EXTENSION AND VALIDATION OF A METHOD FOR LOCATING DAMAGED MEMBERS IN LARGE SPACE TRUSSES

by

Suzanne Weaver Smith
Assistant Professor
Engineering Science and Mechanics Department
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Researchers pursuing the goal to construct a large orbiting space structure are considering many issues, including on-orbit verification of the structure. In previous work, a method was developed for locating damaged members of a large space truss [1,2]. Simulation studies indicated that damage can be located with the approach, although applications for larger structures were limited by the considerable computational effort. Extension of the method was required to overcome this drawback. Also, validation of the method with experimental data was necessary to confirm the method's performance.

The damage location approach employs the control system capabilities for the structure to "test" the structure and measure the dynamic response. The measurements are then used in a system identification algorithm to produce a model of the damaged structure. The model is compared to one for the undamaged structure to find regions of reduced stiffness which indicate the location of damage. Kabe's [3,4] stiffness matrix adjustment method was the central identification algorithm. The strength of his method is that, with minimal data, it preserves the representation of the physical connectivity of the structure in the resulting model of the damaged truss. However, extensive storage and computational effort were required as a result.

Extension of the damage location method to overcome these problems is the first part of the current work. The central system identification algorithm is replaced with the MSMT method of stiffness matrix adjustment which was previously derived by generalizing an optimal-update secant method from quasi-Newton approaches for nonlinear optimization [5]. Structural connectivity is preserved in the resulting stiffness matrix with minimal storage and computational effort. Simulation studies conducted to evaluate the performance of the extended damage location method indicate that results with the MSMT algorithm are comparable to those with Kabe's method. Applications for larger space structures are now possible.

Validation of the extended damage location method is the second goal. Tests on and analyses of a laboratory scale model truss structure [6] were planned to accomplish this. The test article exhibits characteristics expected for large space trusses (ie. closely-spaced frequencies and low damping, among others). Tests with the undamaged structure provide a correlated analysis model which becomes the "original model" in the identification process. Tests on various damaged configurations (one member removed for each case) produce modal data for the damage location process. To date, an initial model is established. Damage location tests are under way.

References

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